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MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 2, 2018/2019

PPH 0135 – ELECTRICITY AND MAGNETISM (Foundation in Engineering)

2 MARCH 2019
2.30 p.m. – 4.30 p.m.
(2 Hours)

INSTRUCTIONS TO STUDENT

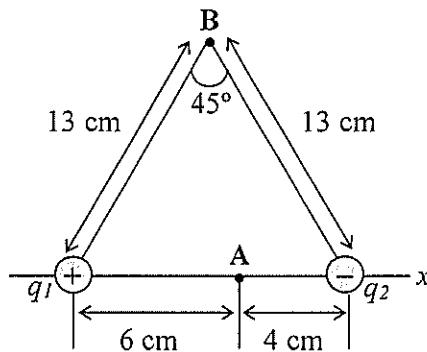
1. This question paper consists of **FIVE** pages excluding the cover page and the appendices with **FIVE (5)** questions only.
2. Attempt **ALL** questions. The distribution of the marks for each question is given.
3. Please write all your answers in the Answer Booklet provided.
4. All necessary workings must be shown.

QUESTION 1 (10 marks)

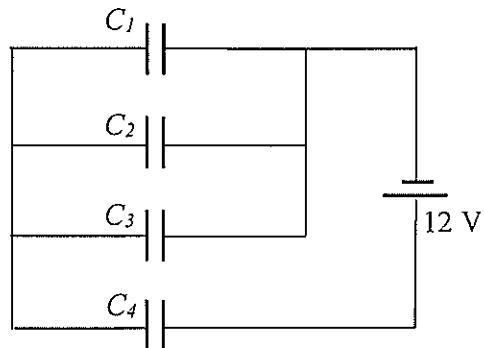
a) An electric dipole consists of two point charges, $q_1 = 12 \text{ nC}$ and $q_2 = -12 \text{ nC}$, placed 10 cm apart (Figure Q1(a)).

i) Compute the potentials at point A and B. [2 marks]

ii) If a charge, $q_3 = 12 \text{ nC}$ is placed at point B, find the magnitude and direction of the net force acting on it (q_3) [3 marks]

**Figure Q1(a)**

b) Figure Q1(b) shows a combination of capacitors in a circuit. Each capacitor has a capacitance of $2.0 \mu\text{F}$.

**Figure Q1(b)**

i) Determine the equivalent capacitance of the circuit. [1.5 marks]

ii) Calculate the amount of charge stored in C_3 . [2 marks]

iii) Determine the voltage across C_2 . [1.5 marks]

Continued ...

QUESTION 2 (10 marks)

a) A battery of $\xi = 2.50$ V has a terminal potential difference of 2.25 V when a resistor of 30.0Ω is connected to it. Calculate the internal resistance, r , of the battery. [2 marks]

b) A DC circuit, consists of two batteries is configured as shown in Figure Q2(a).

i) Write the equation of Kirchhoff's current law applied at point c. [0.5 marks]

ii) Write the equation of Kirchhoff's voltage law for loop abeda and loop cdefe. [2 marks]

iii) Based on parts (i) and (ii), determine I_1 and I_2 . [2.5 marks]

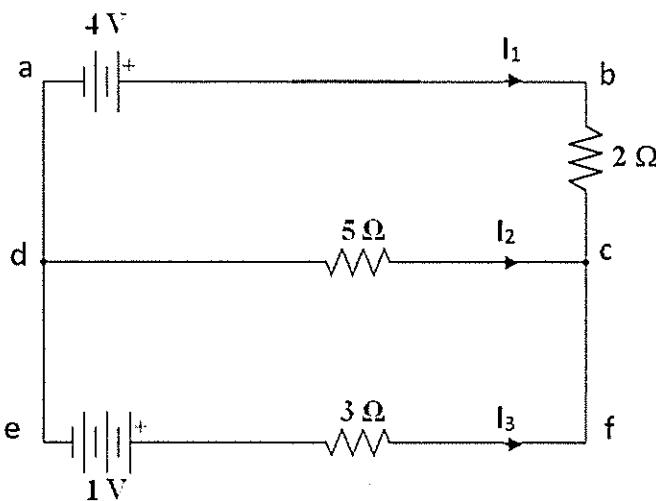


Figure Q2(a)

c) Find the equivalent Thevenin's resistance (R_{TH}) and the equivalent Thevenin's Voltage (V_{TH}) across resistor R_4 for the circuit shown in Figure Q2(b) below.

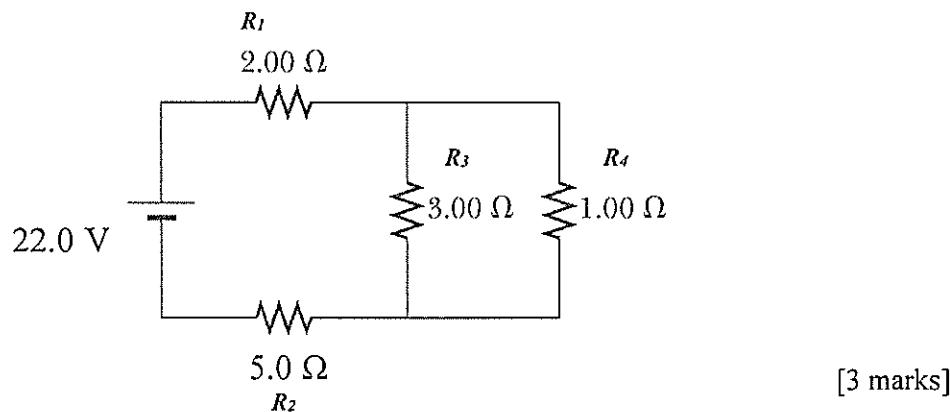


Figure Q2(b)

Continued ...

QUESTION 3 (10 marks)

a) Figure Q3(a) shows a copper wire carrying a current of I in free space. Redraw Figure Q3(a) and sketch the magnetic field produced by the copper wire. [1 mark]



Figure Q3(a)

b) Two wires, X and Y, are carrying currents of 4A and 6A, respectively, as shown in Figure Q3(b).

- Draw the directions of the magnetic field at point P. [1 mark]
- Calculate the magnitude of the magnetic field at point P due to the currents in wire X and wire Y. [2 marks]
- Determine the net magnitude and direction of the magnetic field at point P. [3 marks]

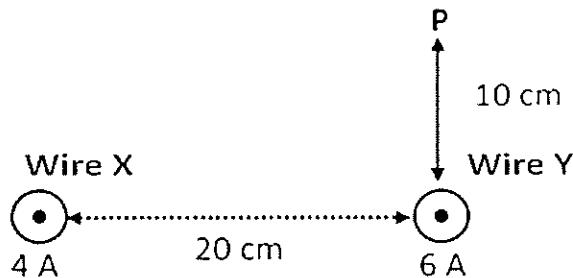


Figure Q3(b)

c) Two solenoids A and B, which are placed close to each other, have 300 and 600 turns, respectively. A current of 1.5A flows through coil A, producing magnetic flux of 1.2×10^{-4} Weber through each turn of A and a flux of 0.9×10^{-4} Weber through each turn of B.

- Determine mutual inductance of A and B. [1.5 marks]
- Find the average e.m.f. induced in coil B when the current in coil A is stopped in 0.2s. [1.5 marks]

Continued ...

QUESTION 4 (10 marks)

a) In a certain series RLC circuit operating at the frequency of 40.0 Hz, the rms current is 4.0A, the rms voltage is 240V, and the current leads the voltage by 50° .

- Find the impedance, Z of the RLC network, hence determine the resistance, R of the circuit at 40 Hz. [2 marks]
- Calculate the reactive power and the apparent power of the circuit at 40 Hz. [2 marks]

b) A series *RLC* circuit containing a 50 Hz power source with $V_{\text{rms}} = 300$ V, a resistor, $R = 200 \Omega$, an inductor, $L = 500$ mH, and a capacitor, $C = 10 \mu\text{F}$.

- Determine the value of the peak voltage of the source. [1 mark]
- Calculate the impedance of the circuit. [3 marks]
- If the frequency of the power source is changed to resonance frequency of the circuit, find maximum current flowing in the circuit. [1 mark]
- Determine the resonance frequency of the circuit. [1 mark]

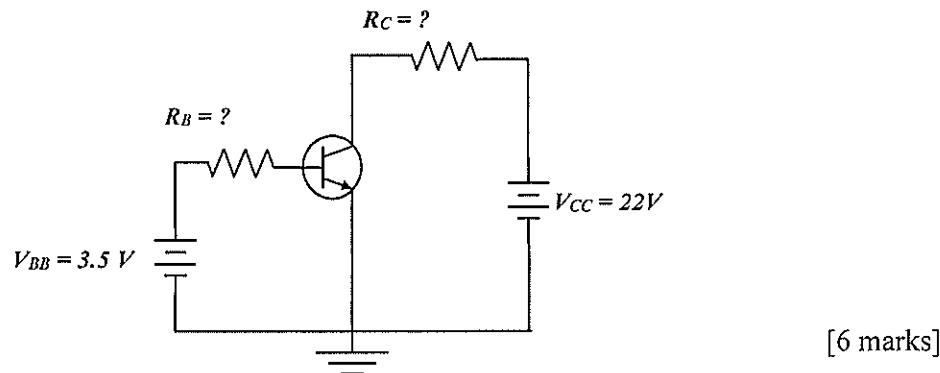
Continued ...

QUESTION 5 (10 marks)

a) What is meant by doping in semiconductors? [1 mark]

b) There are two types of Bipolar Junction Transistor (BJT).
 i) Name the two types of BJT. [1 mark]
 ii) Draw the electronic symbol of each transistor in part (i). Label all terminals in each symbol. [2 marks]

c) Figure Q5 shows a germanium transistor circuit with two unknown resistors, the base terminal resistor R_B and the collector terminal resistor R_C . If the collector current, $I_C = 7.0 \text{ mA}$, $\alpha_{dc} = 0.6$, $\beta_{dc} = 42$, and $V_{CE} = 8.5 \text{ V}$, find the values of R_B and R_C .

**Figure Q5****End of Paper**

APPENDIX 1

Physical Constants

Quantity	Symbol	Value
Electron mass	m_e	9.11×10^{-31} kg
Proton mass,	m_p	1.67×10^{-27} kg
Elementary charge	e	1.602×10^{-19} C
Gravitational constant	G	6.67×10^{-11} N.m ² /kg ²
Gas constant	R	8.314 J/K.mol
Hydrogen ground state	E_0	-13.6 eV
Boltzmann's constant	k_B	1.38×10^{-23} J/K
Compton wavelength	λ_c	2.426×10^{-12} m
Planck's constant	h	6.626×10^{-34} J.s
Speed of light in vacuum	c	3.0×10^8 m/s
Rydberg constant	R_H	1.097×10^7 m ⁻¹
Acceleration due to gravity,	g	9.81 m /s ²
Atomic mass unit (1u)	u	1.66×10^{-27} kg
Avogadro's number	N_A	6.023×10^{23} mol ⁻¹
Threshold of intensity of hearing	I_0	1.0×10^{-12} W /m ²
Coulomb constant	k	8.988×10^9 N m ² /C ²
Permittivity of free space	ϵ_0/κ_0	8.85×10^{-12} C ² /N.m ²
Permeability of free space	μ_0	$4\pi \times 10^{-7}$ H/m

Energy equivalent of atomic mass unit:

One atomic mass unit (1.0 u) is equivalent to 931.5 MeV

APPENDIX II

List of formulas

$A_v = \frac{V_c}{V_b}$	$I = I_{\max} \sin \omega t$	$r = \frac{mv}{Bq}$
$\alpha_{dc} = \frac{\beta_{dc}}{\beta_{dc} + 1}$	$I_{\text{rms}} = \frac{I_{\max}}{\sqrt{2}}$	$\tau = NBIA \sin \theta$
$\beta_{dc} = \frac{\alpha_{dc}}{1 - \alpha_{dc}}$	$I_x = \left(\frac{R_T}{R_x} \right) I_T$	$U = \frac{1}{2} LI^2$
$B = \frac{\mu_0 I}{2\pi r}$	$L = \frac{N\Phi_B}{I}$	$U = \frac{1}{2} B^2 A \frac{l}{\mu_o}$
$B = \mu_0 n I$	$L = \frac{\mu_o N^2 A}{l}$	$V_H = Bvd$
$\xi = V + Ir$	$M = \frac{N\Phi_B}{I}$	$V = V_{\max} \sin \omega t$
$\xi = blv$	$M = \frac{\mu_o N_1 N_2 A}{l}$	$V_{\text{rms}} = \frac{V_{\max}}{\sqrt{2}}$
$\xi = -N \frac{\Delta \Phi}{\Delta t}$	$P = IV = I^2 R = \frac{V^2}{R}$	$V_x = \left(\frac{R_x}{R_T} \right) V_s$
$\xi = -L \frac{dI}{dt}$	$P_t = I_{\text{rms}} V_{\text{rms}} \cos \phi$	$X_C = \frac{1}{2\pi f C}$
$\xi = -M \frac{dI}{dt}$	$P_r = V_{\text{rms}} I_{\text{rms}} \sin \phi$	$X_L = 2\pi f L$
$F = BIL \sin \theta$	$P_a = I_{\text{rms}}^2 Z$	$Z = \sqrt{R^2 + (X_L - X_C)^2}$
$F = qvB \sin \theta$	$R = \frac{\rho L}{A}$	$\oint B \cdot dl = \mu_o I$
$\frac{F}{\ell} = \frac{\mu_0 I_1 I_2}{2\pi d}$	$R = R_0 [1 + \alpha(T - T_0)]$	$d\mathbf{B} = \frac{\mu_o I}{4\pi} \frac{d\ell \times \hat{\mathbf{r}}}{r^2}$
$f_r = \frac{1}{2\pi\sqrt{LC}}$	$R_T = R_1 + R_2 + R_3 + \dots$	$\Phi_B = BA \cos \theta$
$I_{\text{tot}} = \sqrt{I_R^2 + (I_L - I_C)^2}$		$\cos \phi = \frac{R}{Z}$
$I = neA(v_n + v_p)$		$\tan \phi = \frac{X_L - X_C}{R}$
$I = nev_d A$	$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \dots$	
